

# Developing a Sand Management Plan for Galveston Island



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**Sponsor:**

Galveston Park Board of Trustees



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# Outline

- Problem Statement and Approach
- Sediment Budget
- GenCade Calibration
- Sand Management Options at East Beach
- Large-Scale Beach Fill
- GenCade Alternatives
- Sand Management Alternatives and Plan
- Beach Nourishment Project



# Problem Statement/Approach

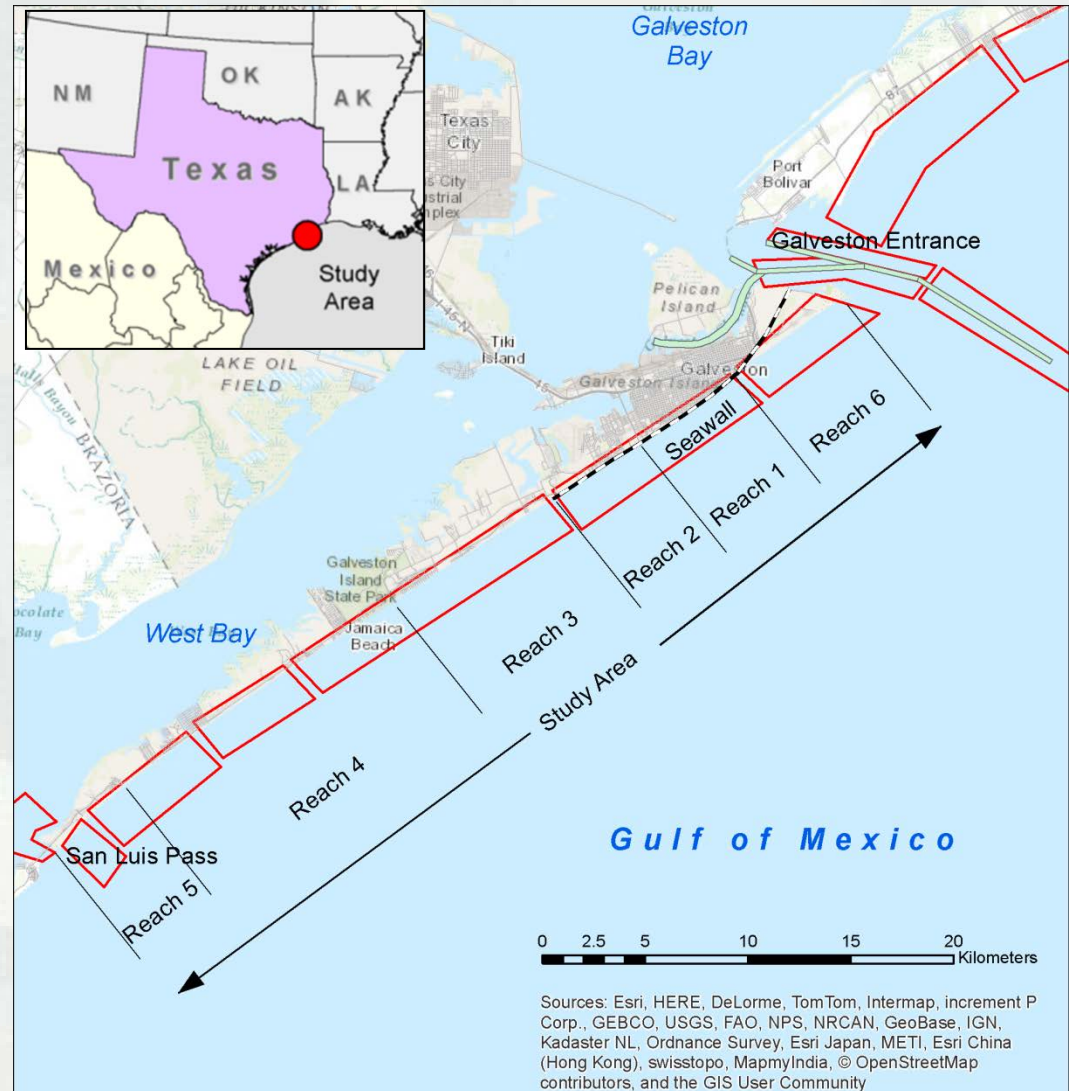
Recommend a long-term plan of actions to better manage sands on Galveston Island

Initial Tasks – Understand physical processes

- Update sediment budget
- Update shoreline change model

Final Tasks

- Evaluate potential solutions/actions
- Formalize and document Galveston Island Sand Management Plan





# Sediment Budget Objectives

- Identify sources and sinks of sediment in coastal system
  - Beach fills
  - Littoral and offshore sources
  - Dredge data
- Compute quantities
- Determine direction of movement using morphologic evidence
- Evaluate sand management alternatives to reduce costs and improve beach resources



# Sediment Budget Equation and the Sediment Budget Analysis System (SBAS)

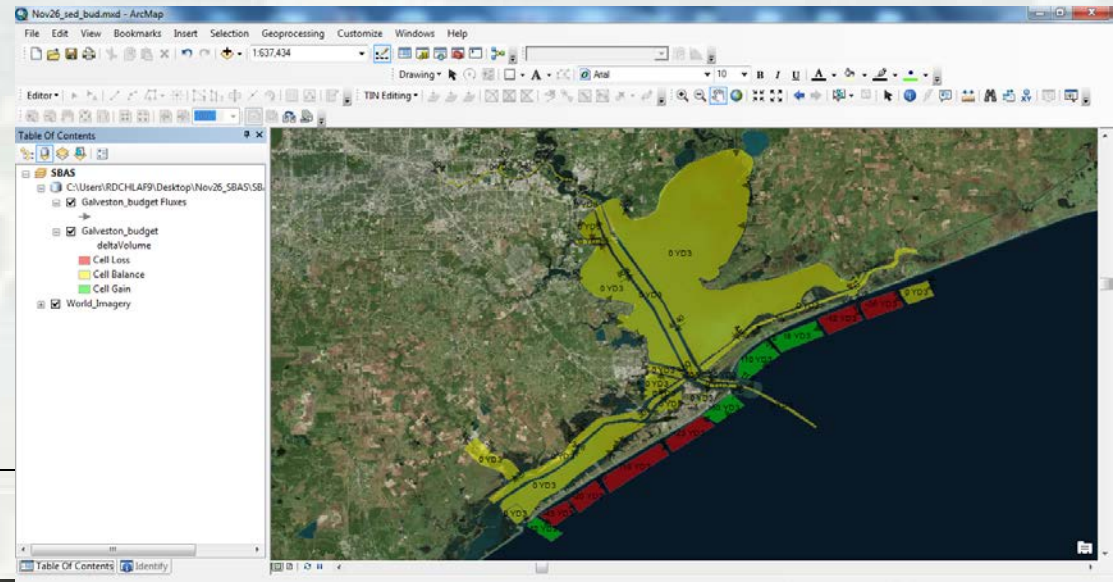
$$\sum Q_{\text{source}} - \sum Q_{\text{sink}} - \Delta V + P - R = \text{Residual}$$

$Q_{\text{source}}$  and  $Q_{\text{sink}}$  = sources and sinks to each cell

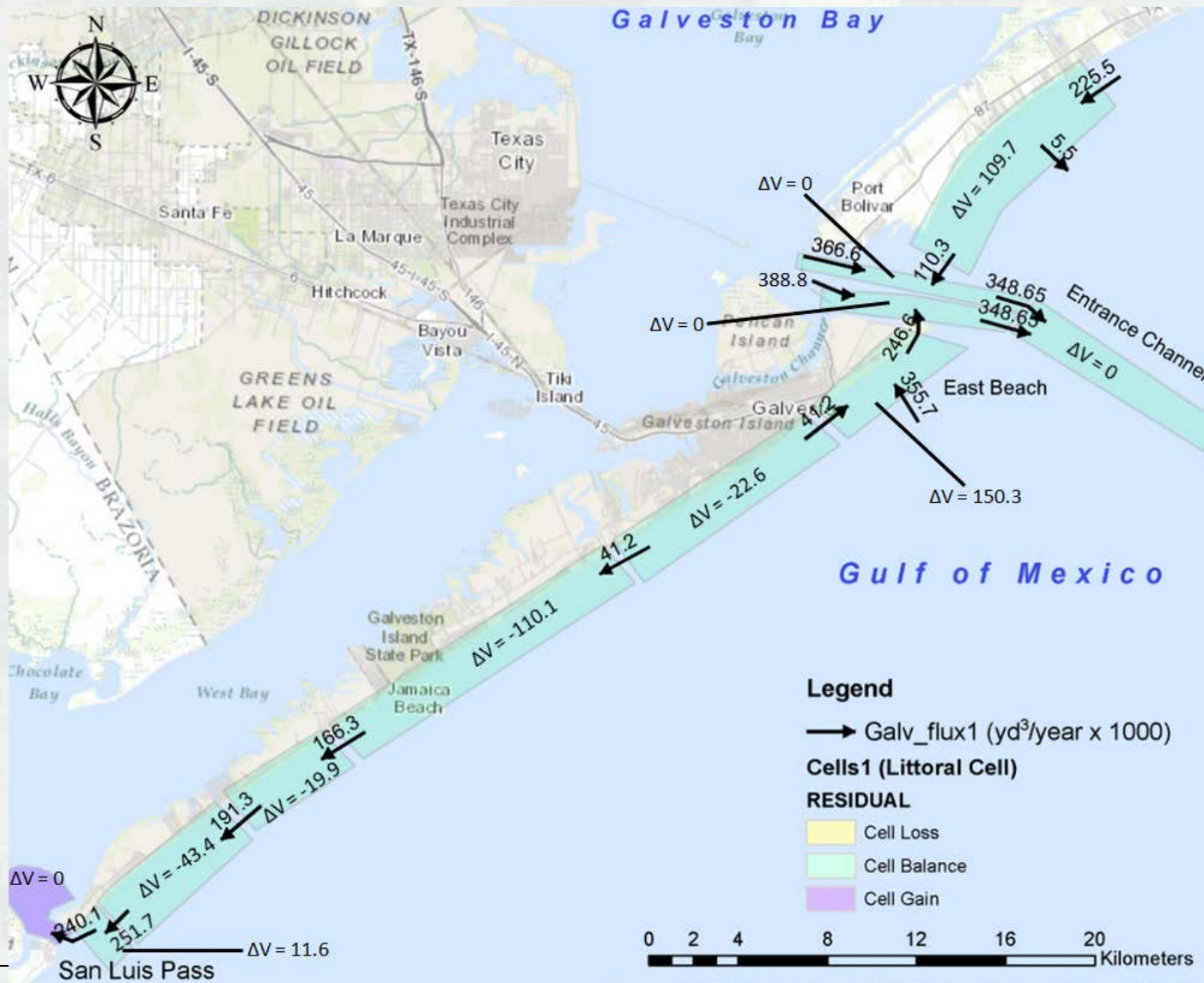
$\Delta V$  = net change in volume in each cell

P = material placed  
(beach fill)

R = material removed  
(dredging)



# Sediment Budget in SBAS



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Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

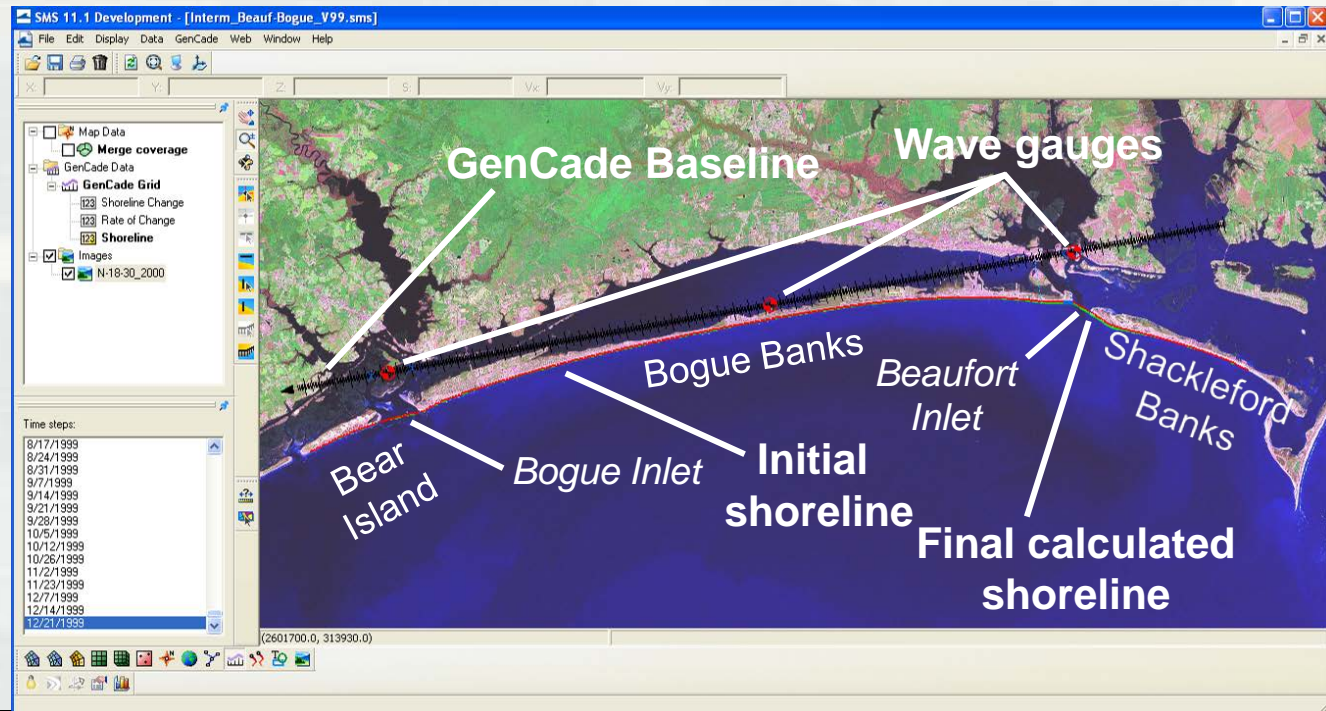


# GenCade Modeling

- Integrated GENESIS and Cascade models for shoreline change and regional sediment calculation
- Connects inlets, navigation channels, ebb and flood shoals, and beaches in engineering activities in a regional framework
- Decision-making support for planning, operation, and engineering
- In SMS 11.1 and higher; PC, user-friendly interface for engineers & scientists

## Purpose:

- Assess shoreline change and longshore transport
- Evaluate sediment management solutions



# GenCade Calibration



## GenCade Input:

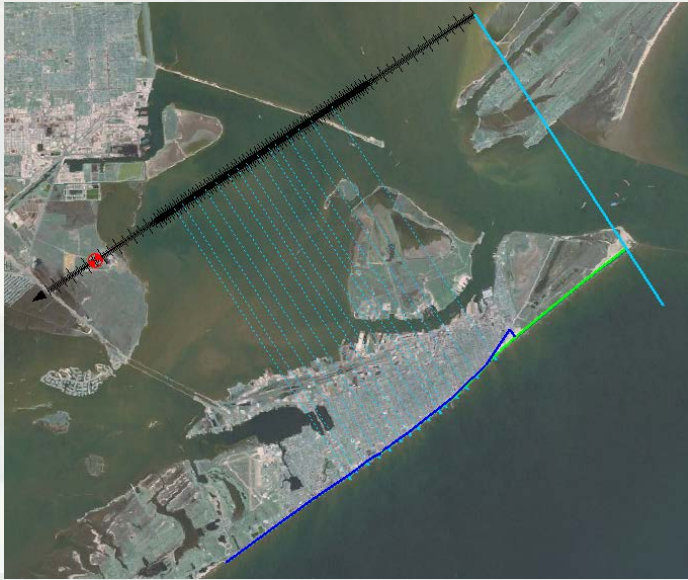
- Two separate grids were used in order to improve results near the west end of the seawall and increase efficiency
- 1995 and 2000 shorelines
- Historical shorelines averaged and smoothed to create regional contour
- Cell spacing ranging from 50 ft (near groins) to 200 ft
- Galveston seawall, groins, and beach fills
- Waves (WIS 73067, 73070)

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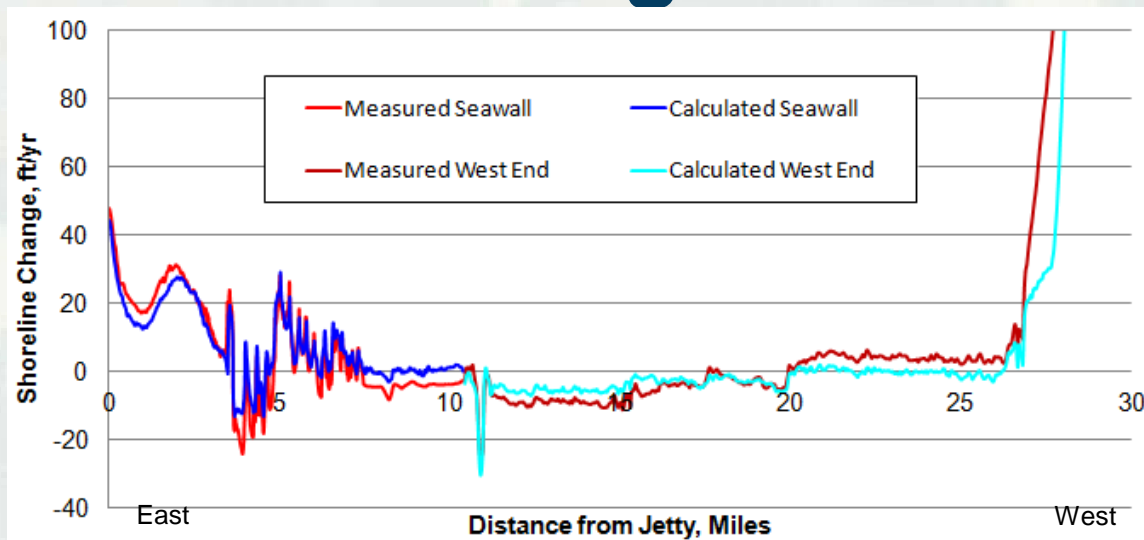
# GenCade Calibration



| Parameter                                       | Value           |
|---|-----------------|
| Start Date                                      | 1/1/1995 0:00   |
| End Date  | 12/31/1999 0:00 |
| Time Step                                       | 0.1 hr          |
| Recording Time Step                             | 168 hr          |
| Effective Grain Size, mm                        | 0.17            |
| Average Berm Height, ft                         | 4               |
| Average Depth of Closure, ft                    | 20              |
| Left Lateral Boundary Condition, Seawall Grid   | Gated           |
| Right Lateral Boundary Condition, Seawall Grid  | Pinned          |
| Left Lateral Boundary Condition, West End Grid  | Moving, -18 ft  |
| Right Lateral Boundary Condition, West End Grid | Moving, 780 ft  |
| K1  | 0.4             |
| K2  | 0.2             |
| ISMOOTH   | 11              |



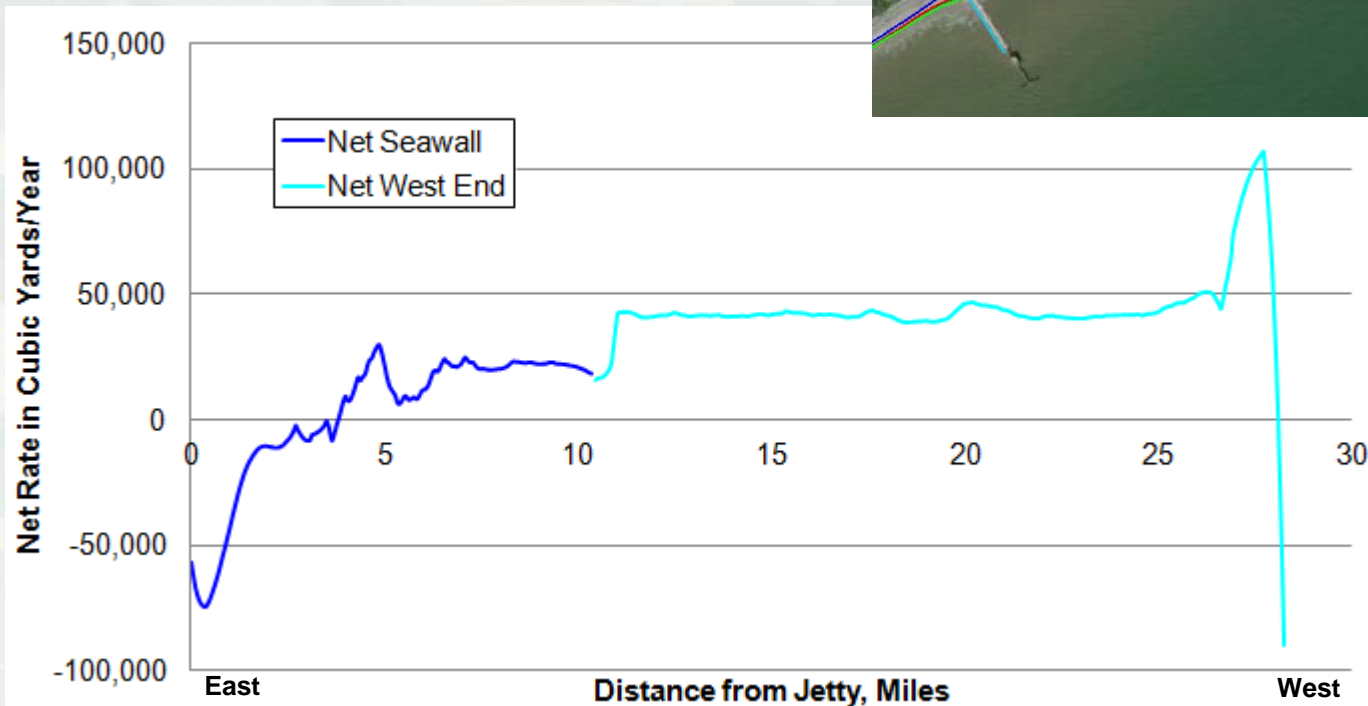
# GenCade Calibration: Shoreline Change Statistics



| Cell                          | Average Shoreline Change, ft/year |         | RMS Error, ft/year | Brier Skill Score |
|-------------------------------|-----------------------------------|---------|--------------------|-------------------|
|                               | Measured                          | Modeled |                    |                   |
| Jetty to first groin          | 18.2                              | 15.1    | 3.8                | 0.96              |
| Groin field                   | 1.6                               | 5.5     | 5.0                | 0.82              |
| Seawall west of groin field   | -3.4                              | 0.5     | 4.0                | 0.87              |
| West end (to 13 Mile Rd)      | -8.1                              | -5.2    | 3.6                | 0.84              |
| 13 Mile Rd. to Jamaica Beach  | -3.3                              | -2.9    | 1.3                | 0.87              |
| Jamaica Beach                 | -0.7                              | -1.5    | 1.1                | -0.27             |
| Jamaica Beach to Indian Beach | -3.3                              | -3.4    | 0.9                | 0.94              |
| Indian Beach to Sea Isle      | 4.1                               | 0.5     | 3.8                | 0.22              |
| Sea Isle area                 | 3.6                               | -0.4    | 4.1                | -0.23             |
| West end 1                    | 5.7                               | -1.2    | 4.7                | 0.54              |
| West end 2                    | 91.3                              | 50.0    | 45.5               | 0.79              |



# GenCade Calibration: Net transport



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# Sediment Management Options

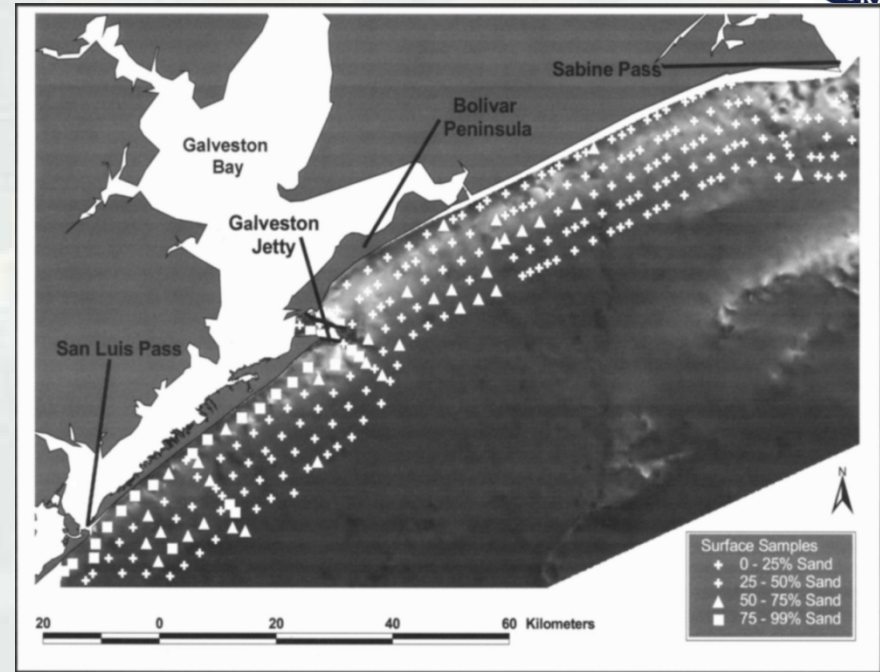
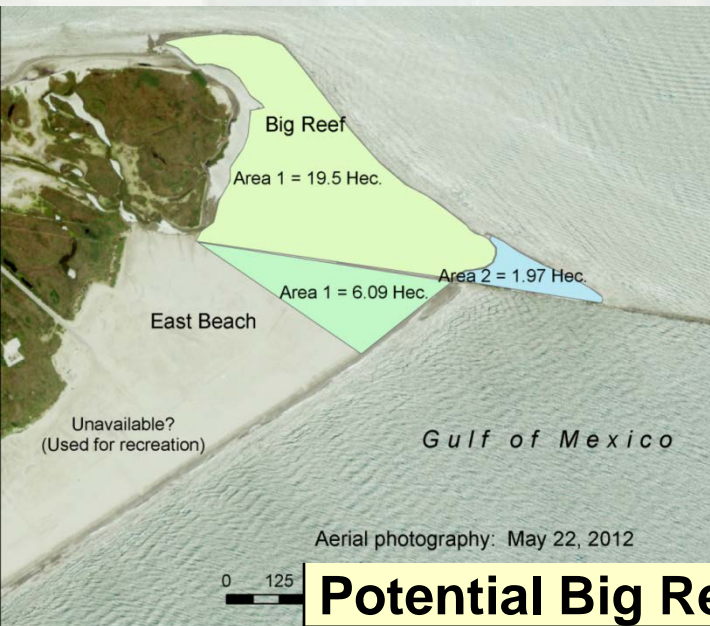


1. Identify sand sources
  - Big Reef
  - East Beach
  - Offshore
2. Deposition basin off East Beach
3. Reduce trans. through S. jetty
4. Reduce Aeolian sand transport
5. Sand backpass system



# Identifying Sand Sources

Big Reef and East Beach east of Boddeker Rd (without recreational or environmental restrictions) = 2+ million yd<sup>3</sup>  
(Incl. offshore Big Reef: 3+ million yd<sup>3</sup>)



Heald Bank: 35 mi offshore with ~ 765,000,000 yd<sup>3</sup>

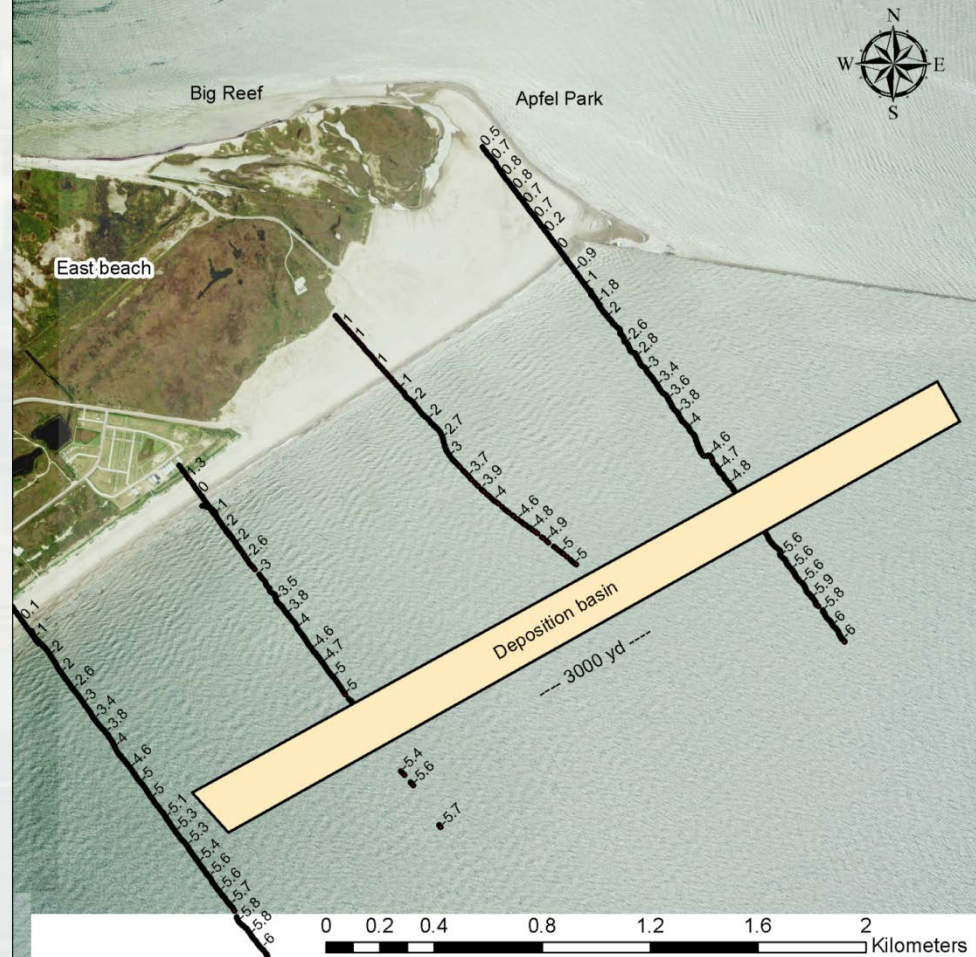
Sabine Bank: 70 mi offshore with ~ 1,600,000,000 yd<sup>3</sup>

## Potential Big Reef Mining Volumes

| Polygon          | Area (m <sup>2</sup> ) | Vol. 1.1 yd layer (yd <sup>3</sup> ) | Vol. 2.2 yd layer (yd <sup>3</sup> ) | Vol. 5.5 yd layer (yd <sup>3</sup> ) |
|------------------|------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| Big Reef Area1   | 195,000                | 255,100                              | 510,100                              | 1,275,300                            |
| Big Reef Area2   | 19,660                 | 25,800                               | 51,400                               | 128,600                              |
| East Beach Area1 | 60,900                 | 79,700                               | 159,300                              | 398,300                              |
| Total            | 275,560                | 360,600                              | 720,800                              | 1,802,200                            |



# Deposition Basin off East Beach



**Sediment Basin Parallel to East Beach**

| East beach coverage (percent) | Length (yd) | 1 yd depth initial volume (yd <sup>3</sup> ) | 2 yd depth initial volume (yd <sup>3</sup> ) | Annual vol. trapped at 50% efficiency (yd <sup>3</sup> ) (based on sed. budget) |
|-------------------------------|-------------|--|--|---|
| 50                            | 3000        | 450,000                                      | 900,000                                      | 90,000  |
| 75                            | 4500        | 675,000                                      | 1,350,000                                    | 135,000   |
| 100                           | 6000        | 900,000                                      | 1,800,000                                    | 180,000   |

Note: Initial dredged volume based on basin 150 yd wide

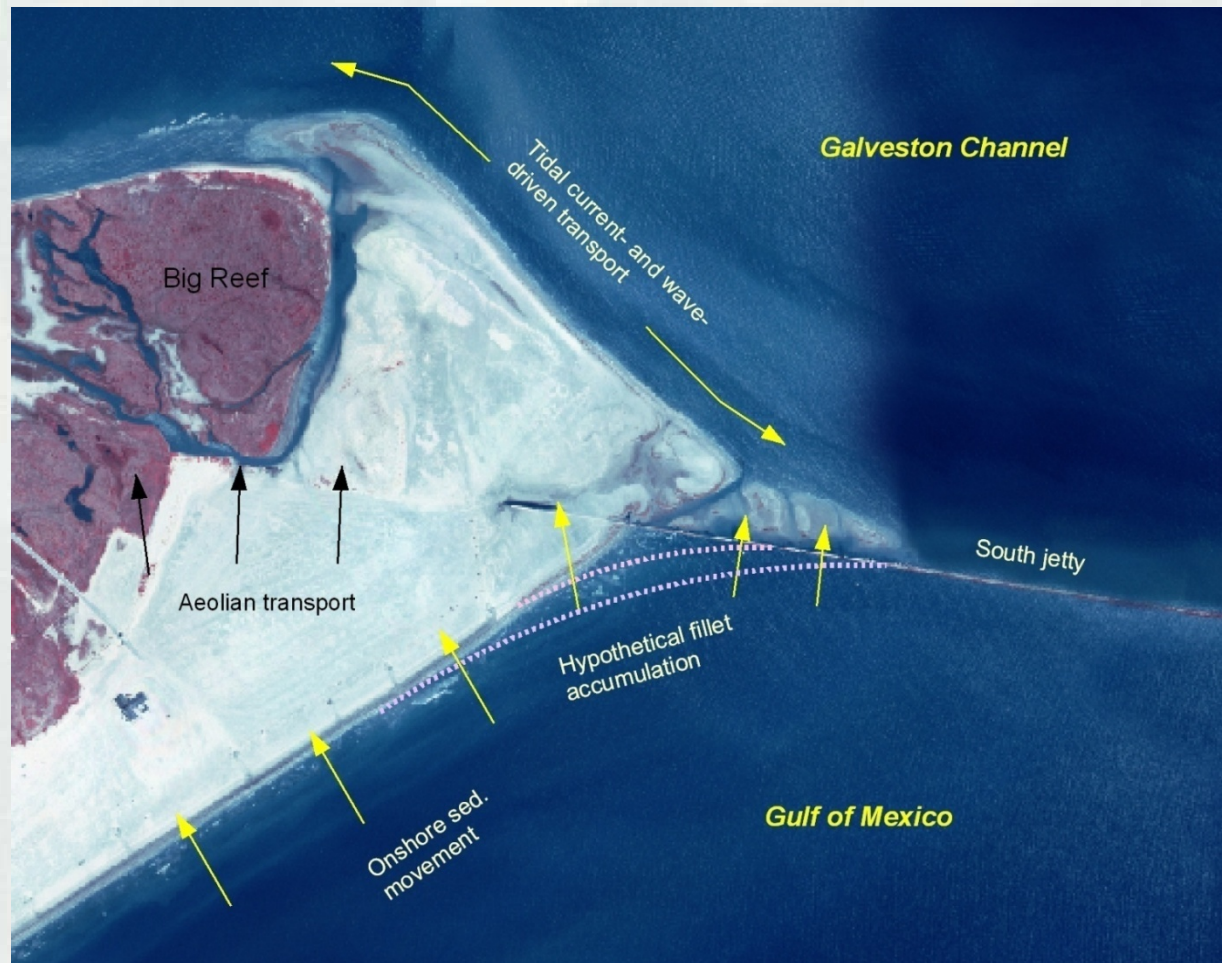


# Reduce transmission through South Jetty

Options:

- Grout
- Geotube
- Sheetpile

Need to be mined regularly



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# Reduce Wind-Blown Sand

## Options:

- Moisture
- Mechanical traps (fencing)
- Vegetation
- 22,000 ft fence or oats = 60-80,000 yd<sup>3</sup>/year



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# Sand Back-Passing/ Pumping

## Design:

- Annual vol.
- Intake location
- Distance
- Intake equipment
  - Movable
  - Fixed plant
- Outlets

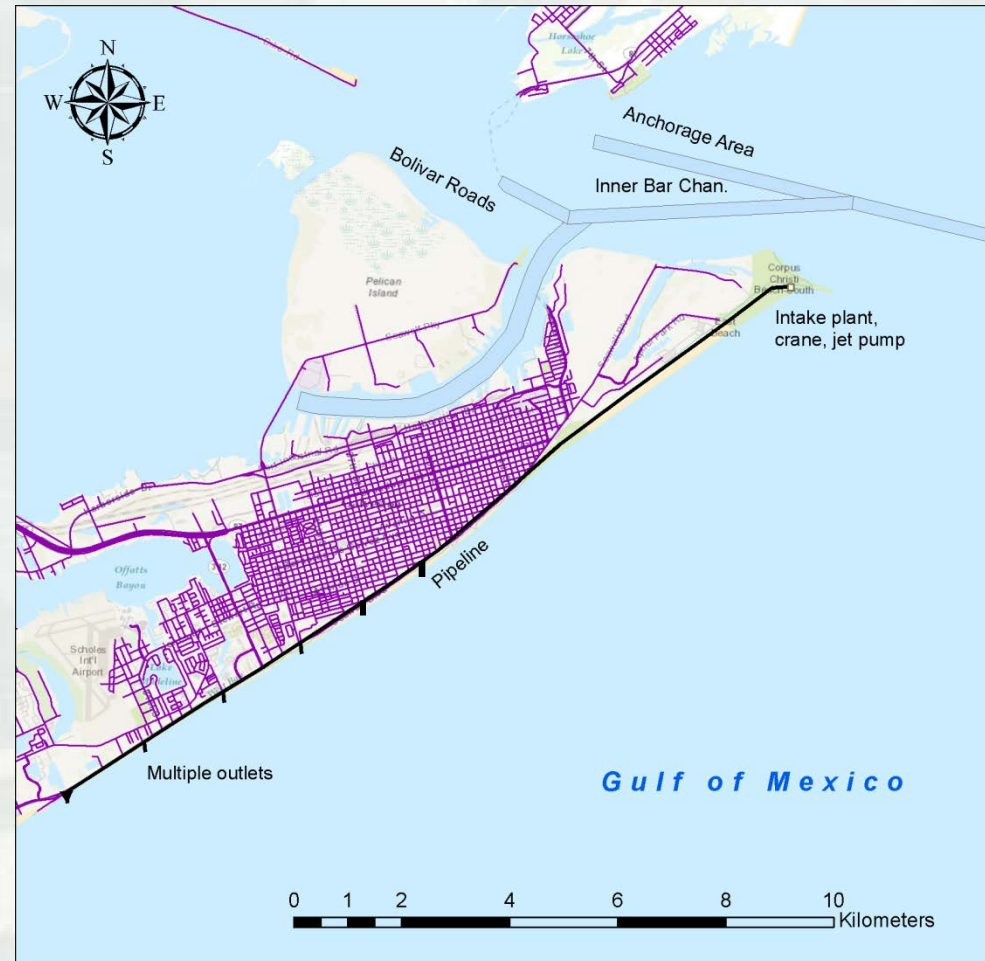
## Advantages:

- No trucks
- Steady use most of year
- Electric supply
- Paved roads
- No need to cross water

**Note:** similar plant at San Luis Pass  
not shown



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# Comprehensive Beach Fill



Proposed width:

- Dune: 100 ft
- Berm/beach: 200 ft

Reach 1: 1,900,000 yd<sup>3</sup>

Reach 2: 3,600,000 yd<sup>3</sup>

Reach 3: 2,500,000 yd<sup>3</sup>

Reach 4: 4,400,000 yd<sup>3</sup>

Reach 5: 500,000 yd<sup>3</sup>

Total: 13,000,000 yd<sup>3</sup>

Plus advance  
nourishment @50%:

**19,500,000 yd<sup>3</sup>**



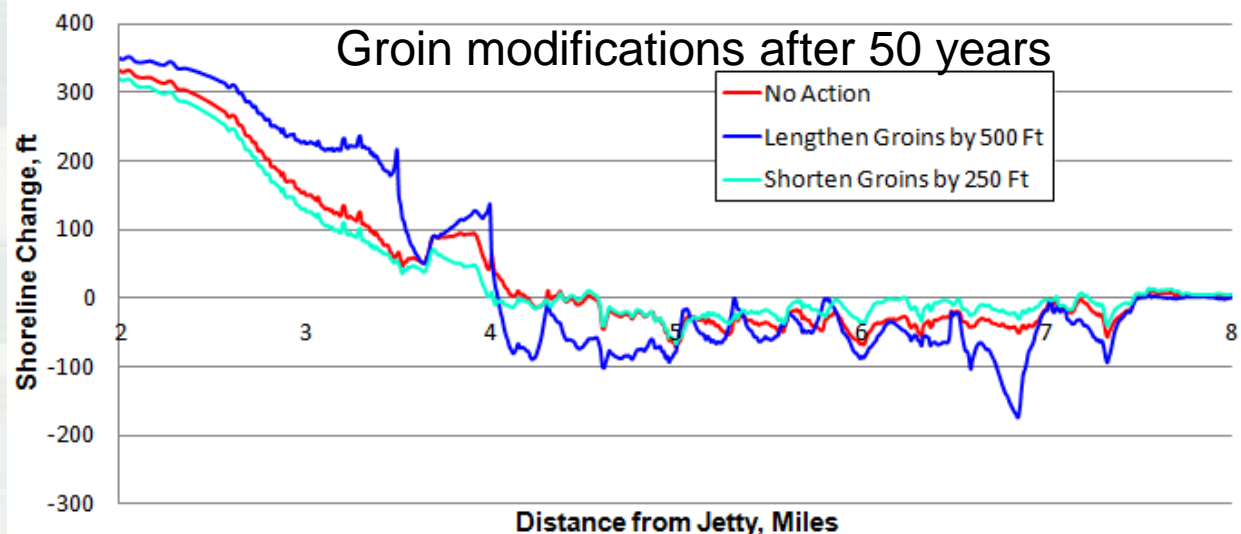
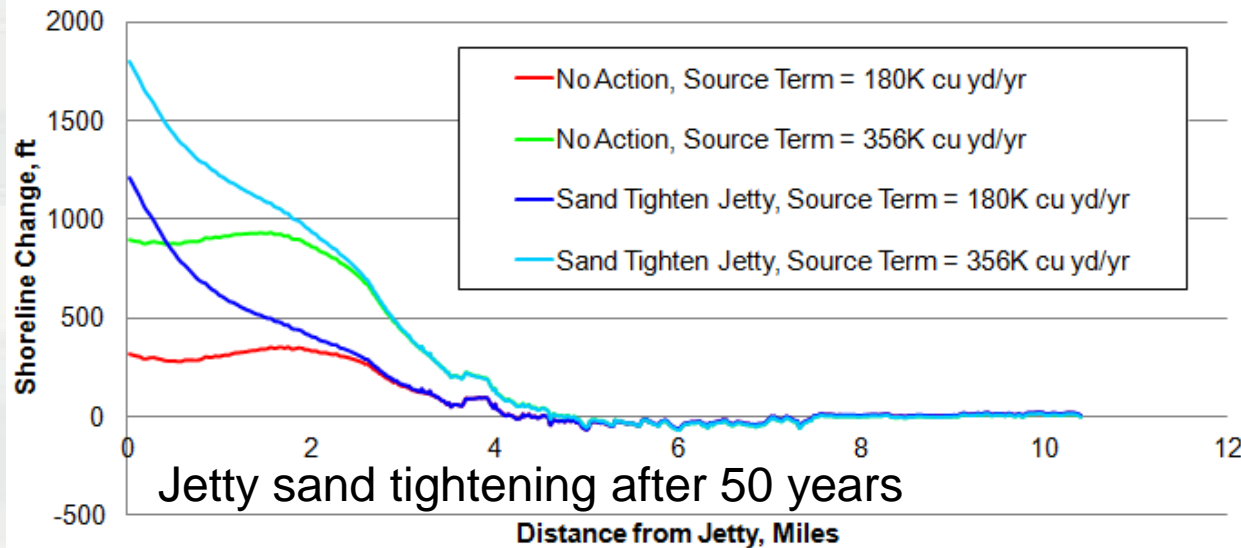
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# GenCade Alternatives

- No Action
- Sand tighten jetty
- Beach fills
- Backpassing



# Structural Alternatives

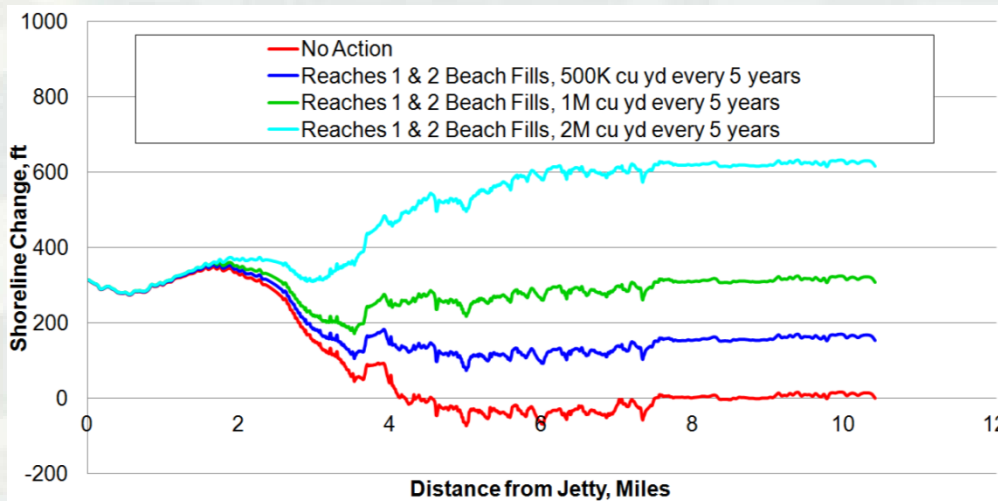
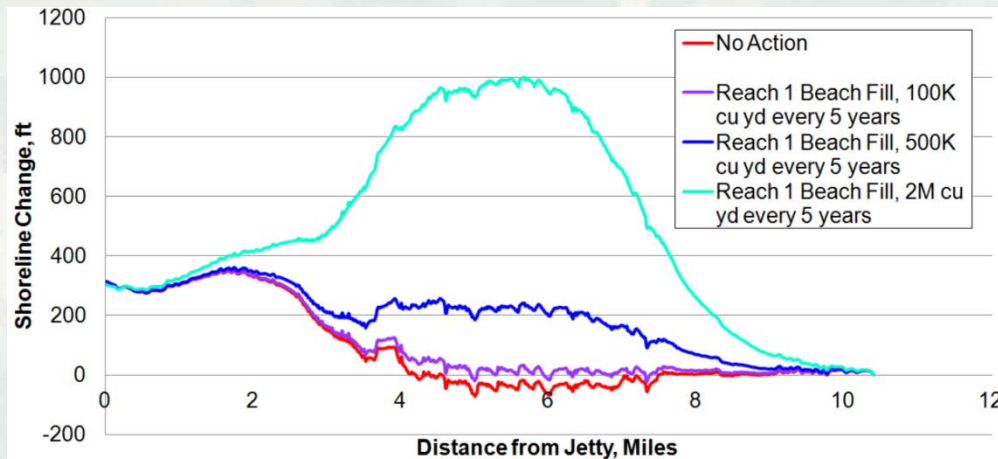


- Sand tightening the jetty advances the shoreline significantly and provides more material for backpassing and beach fills
- Lengthening, shortening, or removing groins makes little difference in shoreline position after 50 years
- If a beach fill is also constructed, shortened or existing groins will mostly be buried

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# Beach Fill Alternatives (Seawall)



100,000 yd<sup>3</sup>, 500,000 yd<sup>3</sup>, and 2,000,000 yd<sup>3</sup> every 5 years

(Top: Reach 1 only,

Bottom: Reaches 1 and 2)

- Renourishment volume equal to initial fill volume

- 100,000 yd<sup>3</sup> every 5 years (Reach 1 only) is enough sand to keep beach similar to present conditions

- 500,000 yd<sup>3</sup> advances beach 200 ft after 50 years (Reach 1)

- Material not taken from near jetty (either channel dredging or offshore)

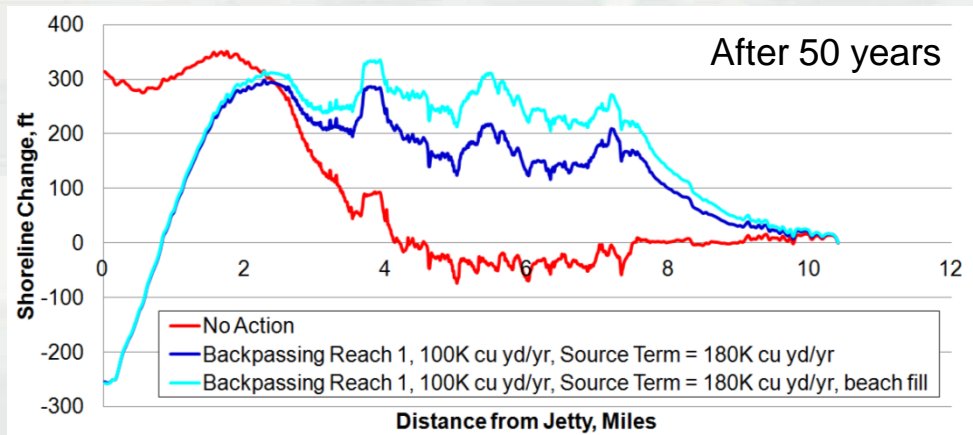


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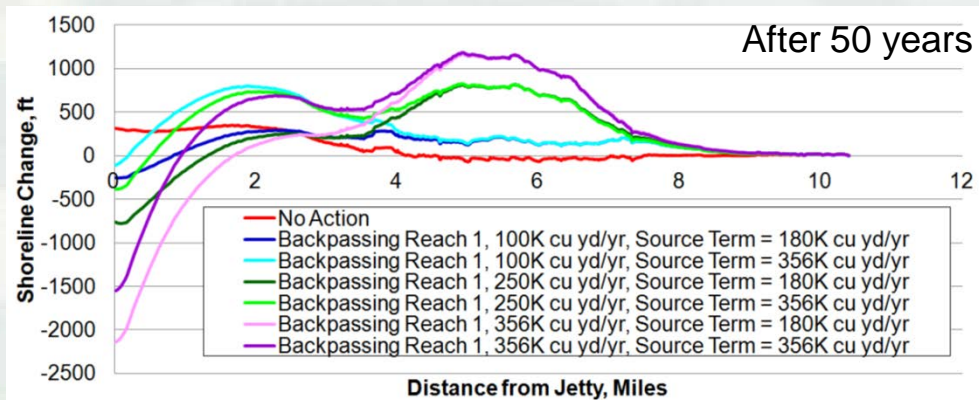
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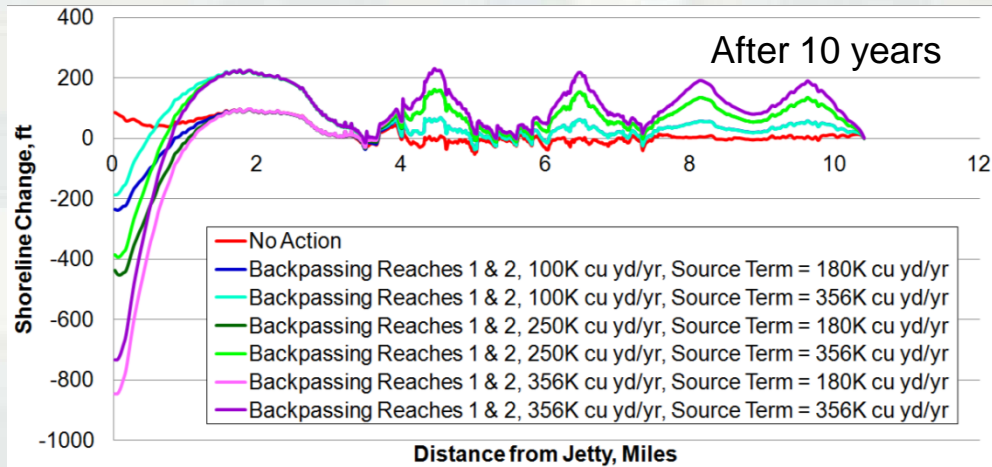
# Backpassing (Seawall)



Top: 100,000 yd<sup>3</sup>/yr backpassed to Reach 1, with and without 1,900,000 yd<sup>3</sup> initial beach fill  
 Bottom: 100,000, 250,000, and 356,000 yd<sup>3</sup> backpassed with different rates of material moving onshore

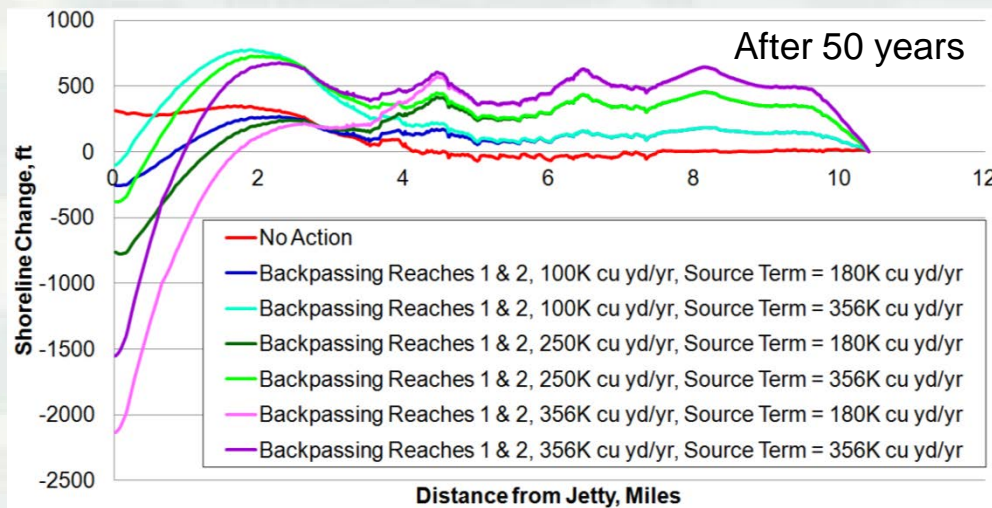


# Backpassing (Seawall)



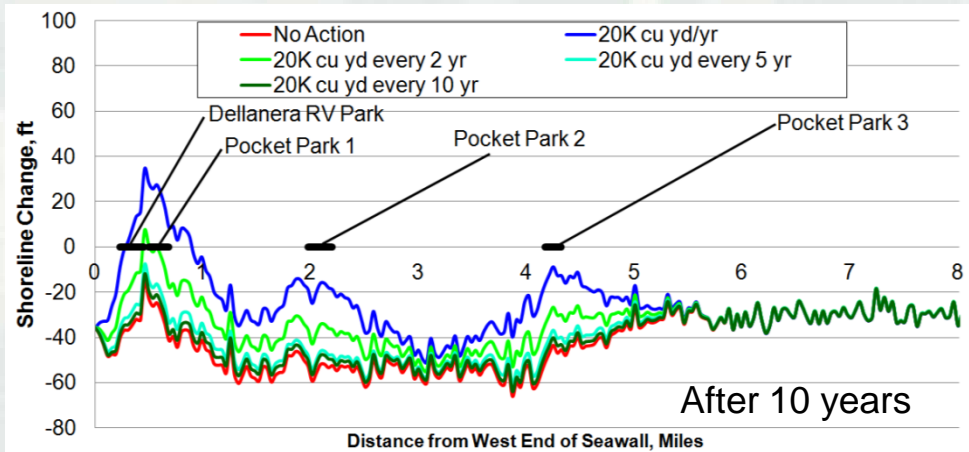
100,000, 250,000, and 356,000 yd<sup>3</sup> backpassed onto Reaches 1 and 2

- various rates of sand moving onshore to illustrate impact on shoreline



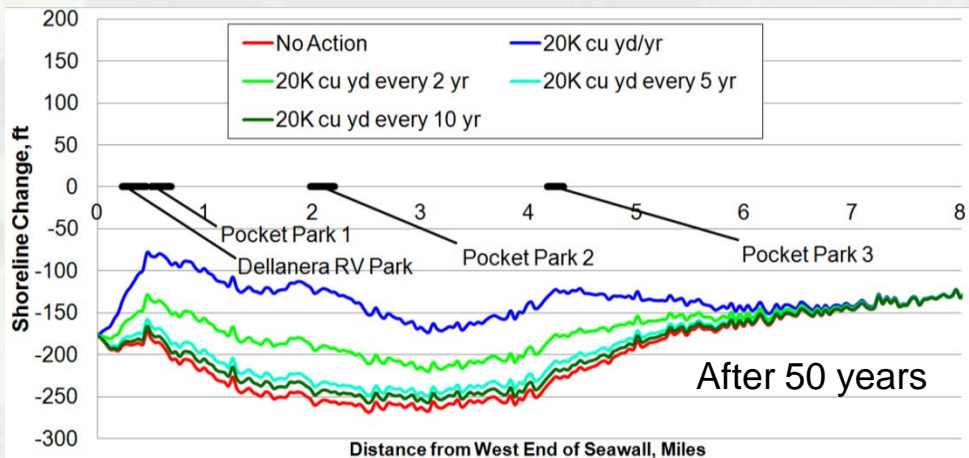


# Beach Fills (West End)

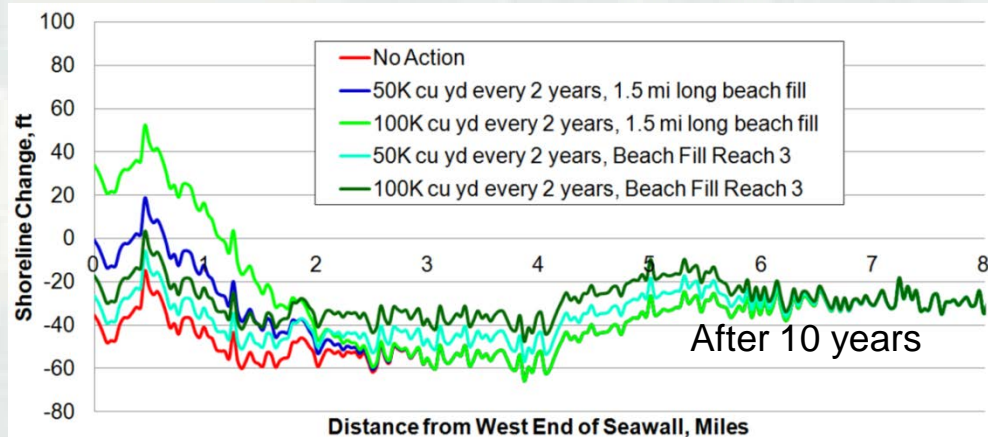


Beach fills placed on Park Board property

- 20,000 yd<sup>3</sup> at each property = 80,000 yd<sup>3</sup> total per placement
- Placement every year = 4,000,000 yd<sup>3</sup> total; still more than 100 ft of erosion

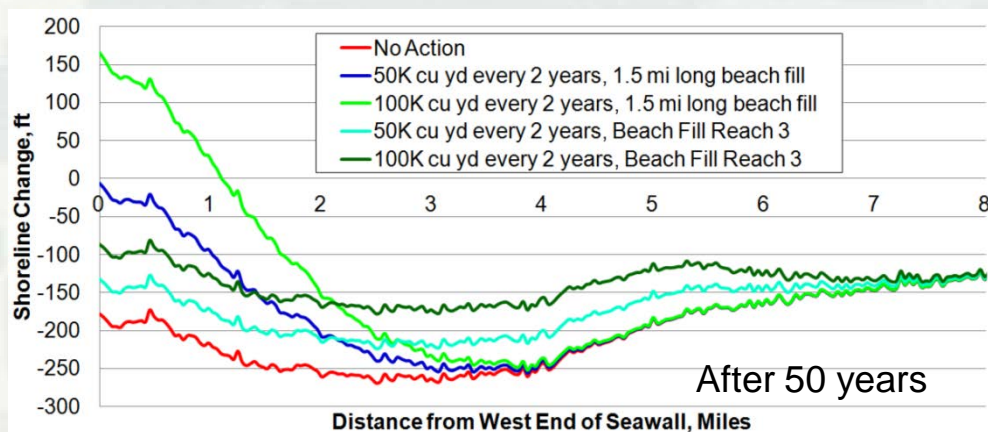


# Beach Fills (West End)

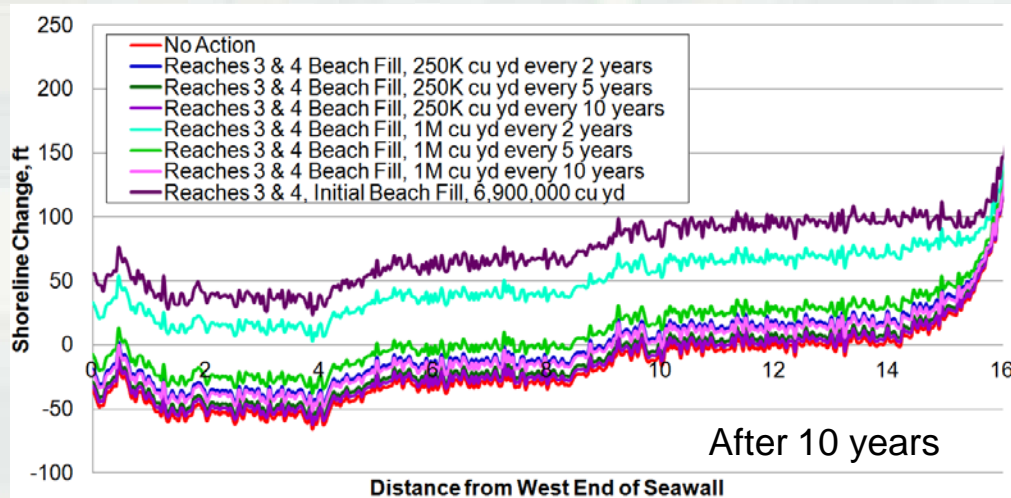


Beach fills along first 1.5 mi past seawall and along Reach 3

- 50,000 or 100,000 yd<sup>3</sup> placed every 2 years
- After 50 years, no alternative results in shoreline advance along Reach 3

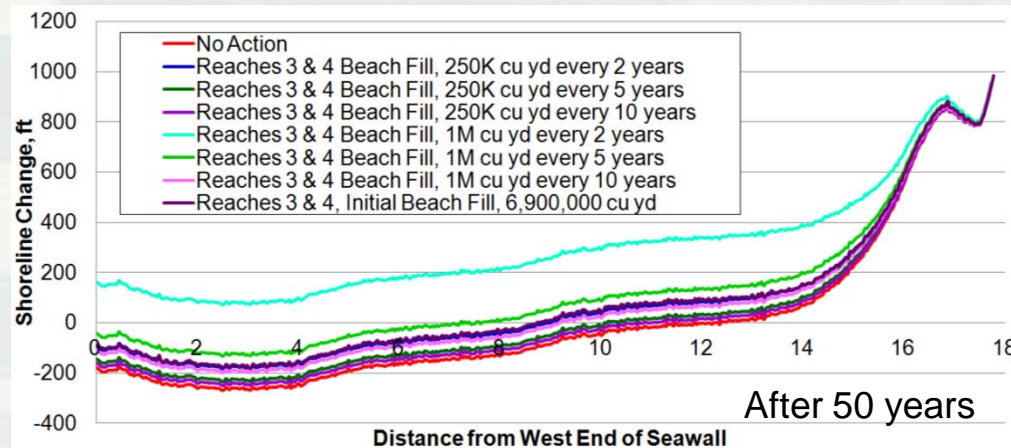


# Beach Fills (West End)



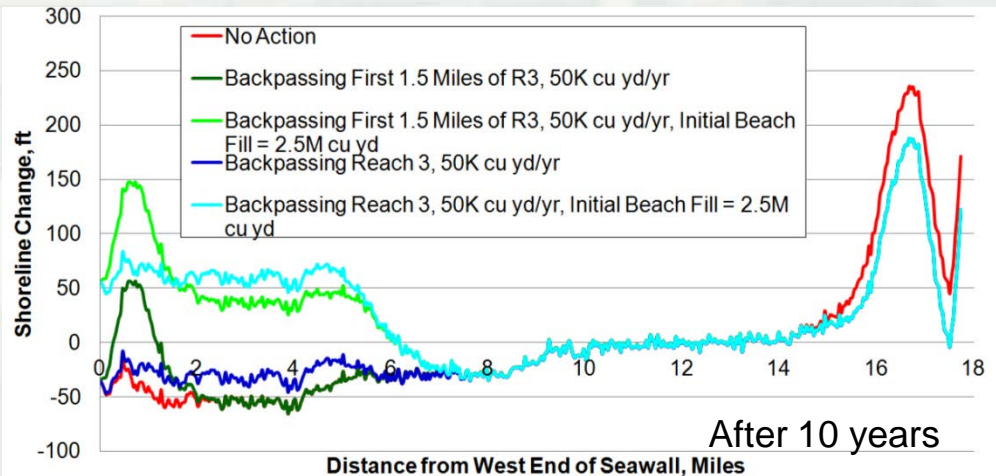
Beach fills along Reaches 3 and 4

- 250,000 or 1,000,000 yd<sup>3</sup> placed every 2, 5, or 10 years
- After 50 years, the only alternative resulting in shoreline advance is 1,000,000 yd<sup>3</sup> placed every 2 years



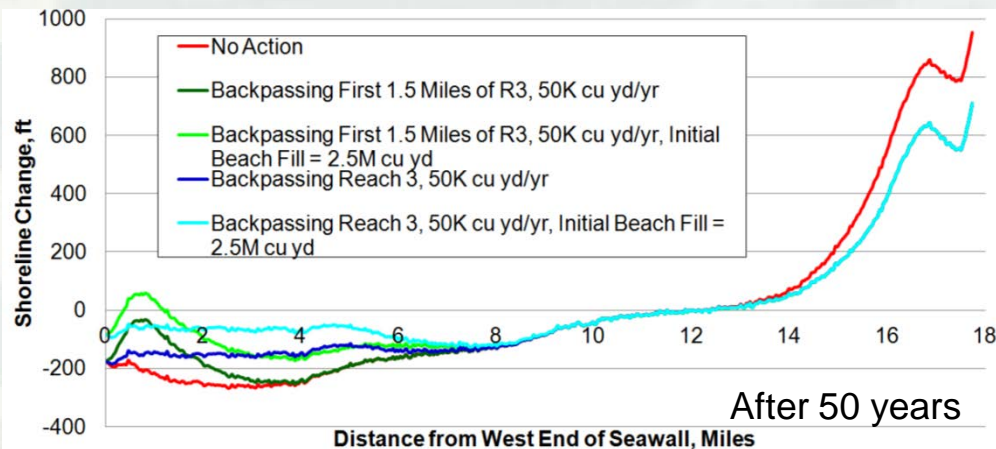


# Backpassing (West End)



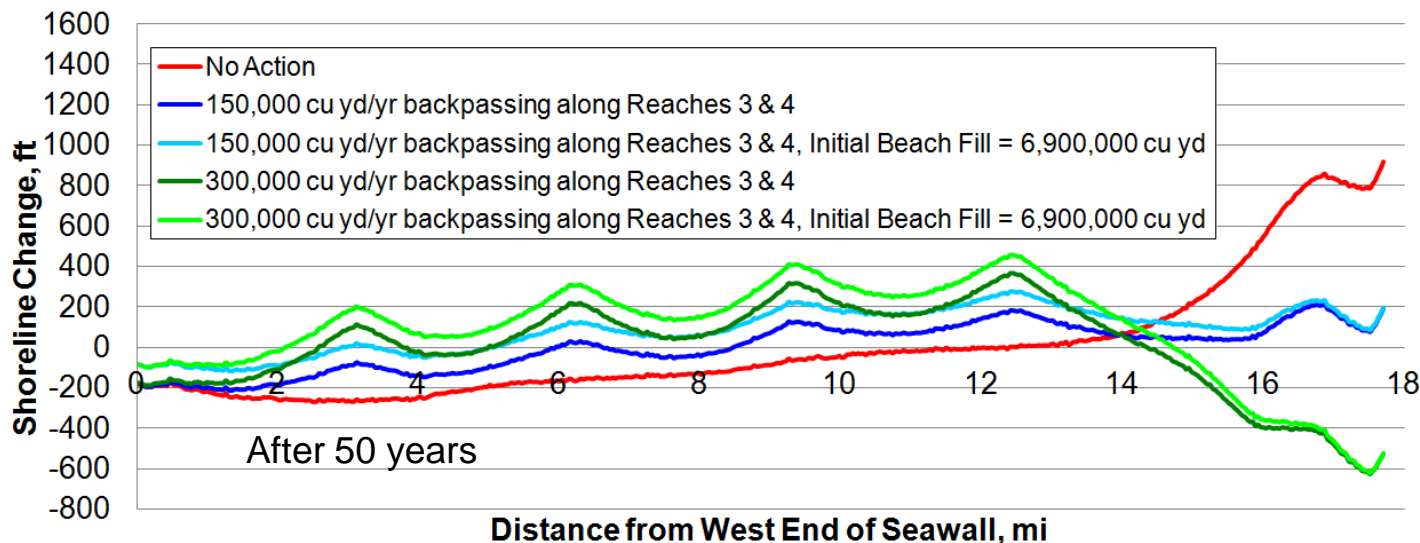
Backpassing to first 1.5 mi beyond seawall and to Reach 3

- 50,000 yd<sup>3</sup>/yr backpassed
- With and without initial beach fill along Reach 3 = 2,518,800 yd<sup>3</sup>



# Backpassing (West End)

- Backpassing to Reaches 3 and 4
- 150,000 and 300,000 yd<sup>3</sup>/yr backpassed
  - With and without initial beach fill = 6,926,700 yd<sup>3</sup>



# Sand Management Alternatives

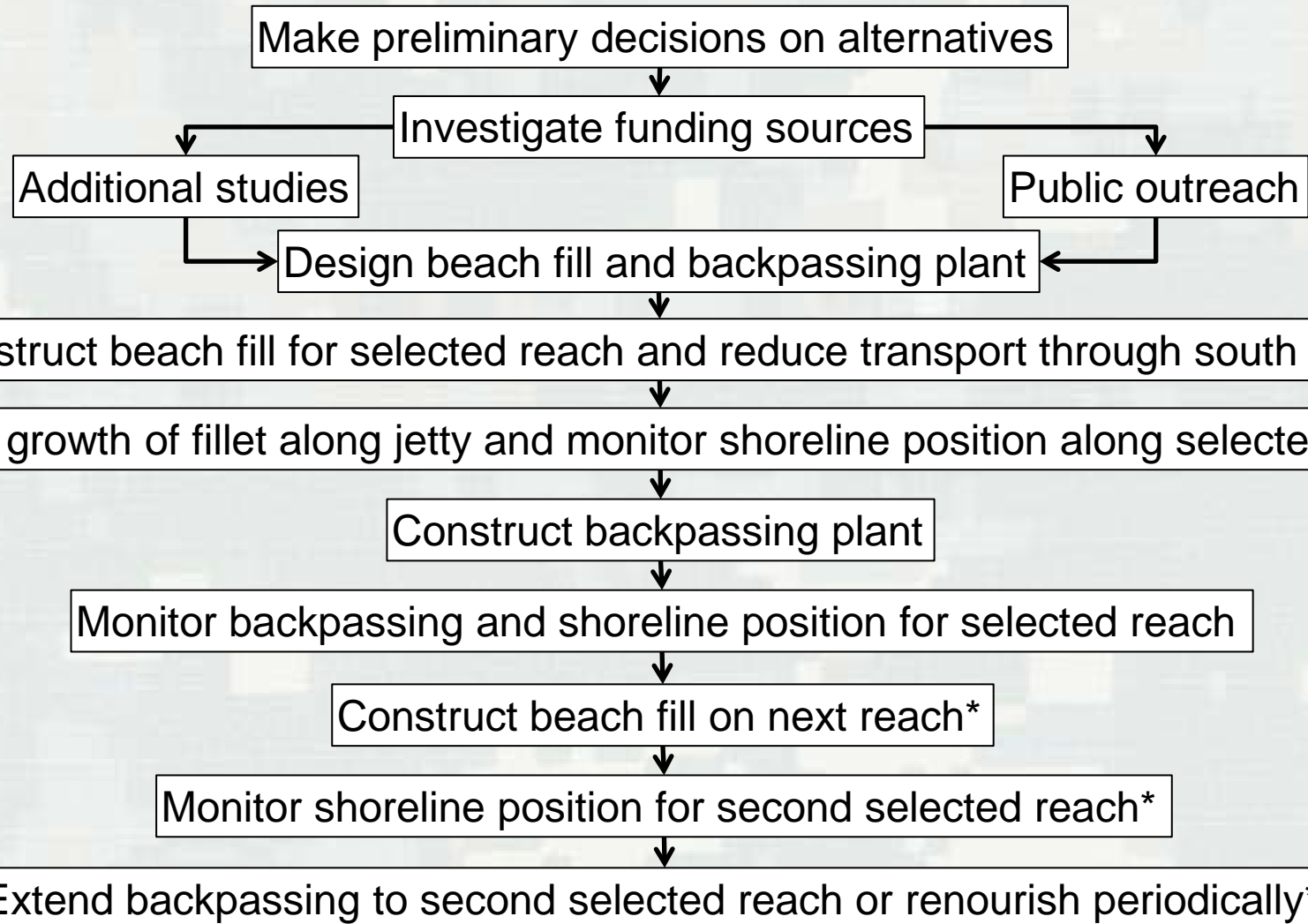


| <b>Plan</b>              | <b>Coverage</b> | <b>New Material<br/>(offshore or<br/>other<br/>sources)</b> | <b>Management and<br/>recycling of<br/>existing sand<br/>sources and<br/>dredge material</b> | <b>Performance<br/>monitoring</b> |
|--------------------------|-----------------|---|--|-----------------------------------|
| Comprehensive beach fill | Reaches 1-5     | √   | √  | √                                 |
| Limited area beach fill  | 1, 2, 3(?)      | √   | √  | √                                 |
| Systematic recycle       | 1, 2            |   | √  | √                                 |
| Present action plan      | 1               |   | √  |                                   |
| No action                |                 |   |  |                                   |





# Sand Management Plan



\* Continue process until all desired reaches are completed



# Adaptive Management and Monitoring



- Implement adaptive management strategy
  - Construct limited fill and monitor to ensure it is responding as expected
  - Modify design if necessary
- Recommended monitoring actions
  - Beach profiles, lidar, and/or shoreline position should be collected prior to and every 6 months after construction
  - Georeferenced aerial photography once a year



# Beach Nourishment Project

- Project began in August
- 725,000 yd<sup>3</sup> dredged from Galveston Entrance Channel
- Placing material on Reach 2 (between 61<sup>st</sup> and 81<sup>st</sup> St.)
- Collaborative effort between Galveston Park Board, City of Galveston, Texas General Land Office, and U.S. Army Corps of Engineers, Galveston
- Channel dredged every 18 to 24 months and material will be placed on beach instead of offshore







# Questions?

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